Doc Ref. FG4
Appl. No. 10/822,855

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : 0 590 677 A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number : 93115854.7

(22) Date of filing : 30.09.93

(51) Int. Cl.^{5} : B29C 45/27

(30) Priority : 30.09.92 US 954289

(43) Date of publication of application :
06.04.94 Bulletin 94/14

(84) Designated Contracting States :
AT BE CH DE DK ES FR GB GR IE IT LI LU NL PT SE

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(54) Sealed edge gate.

(57) The present invention relates to a hot runner sealed edge gated injection molding system. The system includes a mold cavity plate (28) with at least one injection gate (16) and a nozzle assembly (12) having a tip end (40) and at least one melt channel (14, 38) for transporting molten plastic material. The system further includes an annular seal ring (42) which fits snugly over the tip end of the nozzle assembly. The seal ring has at least one melt channel (56) and at least one orifice (54) for transporting molten plastic material from the at least one melt channel in the nozzle assembly to the at least one injection gate in the mold cavity plate. In a preferred embodiment, the seal ring is formed from a material having a thermal coefficient of expansion lower than the thermal coefficient of expansion of the material forming the nozzle. As a result, the nozzle when heated will expand at a greater rate than the seal ring resulting in an effective sealing arrangement with the seal ring being pressed against the mold cavity plate and being gripped by the nozzle.

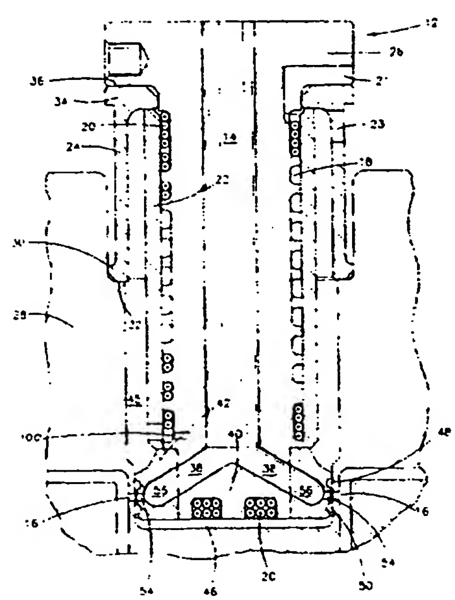

FIG-1

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Background of the Invention

The present invention relates to an improved nozzle assembly for an injection molding machine and, more particularly, to an improved sealed edge gate arrangement to be used therein.

Hot runner edge gating systems are well known in the art. When such systems are used to process heat sensitive resins however, it becomes important to minimize or, if possible, eliminate any bubble or resin insulation well so as to avoid degraded resins, trapped within the nozzle assembly and its components, from being drawn into the main melt stream and thereby into the molded part.

U.S. Patent Nos. 4,344,750 to Gellert and 4,981,431 to Schmidt show typical non-bubble type hot runner edge gating systems. The system shown in the Gellert patent uses individual hollow seals to connect the hot runner nozzle directly to the cavity gate. This totally eliminates the bubble because the nozzle is completely surrounded by an insulating air gap. The seals used in this system are pressed into recesses in the nozzle, one seal for each gate. As the nozzle assembly is fitted into the mold cavity plate, the seals deform slightly inwardly so as to effect a mechanical seal with the cavity plate. Removal and replacement of the nozzle for servicing requires the replacement of the seals each time. Another disadvantage of this approach is that the seal is made of titanium, which although having a lower thermal conductivity than steel, still permits a significant amount of heat to be conducted from the heated nozzle to the cooled mold cavity. As a consequence, the nozzle has to be heated to a higher temperature than would otherwise be required to process the resin. Normally this is not detrimental, but when heat sensitive resins are processed, this can be troublesome since these resins easily degrade at temperatures only slightly higher than their processing temperature.

The Schmidt patent also uses individual titanium seals individually screwed into the nozzle assembly. The seal design uses a very small bubble to locally insulate the gate from the nozzle and thereby reduce the heat conducted through the seal. A disadvantage of this design is that the stiffer seal construction is less elastic and does not readily deform during installation like the Gellert seal. This means greater accuracy in manufacture and assembly are required in order to assemble the nozzle. Also, since this seal is larger than the Gellert seal, there is less space in the nozzle to accommodate multiple seals for multiple gating. The most attempted has been four. Additional orifices tend to weaken the nozzle at the tip end where strength is most important. At the tip end, the injected resin travelling at high speed anc under high pressure must change direction through ninety degrees subjecting the end of the nozzle to very high stresses. The risk of blowing the end off the nozzle is increased by the addition of seals for multi-cavity gating.

Both of the sealing devices shown in the Gellert and Schmidt patents have the disadvantage that the sealing and the location of the gates is local to each gate. Thus, in a two cavity arrangement, there is a tendency for the nozzle assembly to cock or jam when being assembled or disassembled since alignment and contact with the mold cavity occurs in only two places within the mold cavity location diameter.

Accordingly, it is an object of the present invention to provide an improved sealed edge gate system for an injection molding system.

It is a further object of the present invention to provide an edge gate system as above which facilitates the processing of heat sensitive resins.

It is still a further object of the present invention to provide an edge gate system as above which provides a nozzle assembly having improved thermal insulation properties.

Other objects and advantages of the present invention will become more apparent from the following description and the accompanying drawings in which like reference numerals depict like elements.

Summary of the Invention

The foregoing objects are attained by the sealed edge gate system of the present invention. In accordance with the present invention, a hot runner sealed edge gated injection molding system comprises a nozzle assembly having a tip end and at least one melt channel extending into the tip end and an annular seal or sealing ring snugly fitted over the tip end of the nozzle assembly. The seal ring has at least one melt channel for mating with the at least one melt channel in the nozzle assembly.

The seal ring of the present invention is further characterized by the presence of one or more orifices which can be aligned with one or more gates in a mold cavity plate and by the presence of two circumferential bubble grooves and a circumferential film groove about its periphery for receiving molten plastic material which acts as a thermal insulator. The seal ring is preferably formed from a material having a lower thermal coefficient of expansion than the material forming the tip end of the nozzle assembly. In this way, a gripping force can be generated on the seal ring when the nozzle assembly and/or the tip end is heated and an effective sealing arrangement can be created between the seal ring and the mold cavity plate.

Still other features of the sealed edge gated injection molding system and the seal ring will be described in the following description.

Brief Description of the Drawings

Figure 1 is a cross sectional view of a nozzle as-

sembly with a sealed edge gate in accordance with the present invention;

Figure 2 is an enlarged view of a portion of the nozzle assembly of Figure 1; and

Figure 3 is a perspective view of a seal ring in accordance with the present invention.

Detailed Description

Referring now to the drawings, Figure 1 illustrates a nozzle assembly for an injection molding system. The nozzle assembly includes a nozzle 12 formed from a thermally conductive material, such as steel or a copper alloy, having a central melt channel 14 through which molten plastic material is transferred from a source (not shown) to one or more injection gates 16 in a mold cavity plate 28. As shown in Figure 1, the central melt channel 14 can terminate in one or more angled melt channels 38 located in or extending into a tip end 40 of the nozzle 12. It should be recognized that, while only two angled melt channels 38 have been illustrated in Figure 1, the melt channel 14 could terminate in any desired number of angled melt channels 38 with the number of such angled melt channels generally corresponding to the number of injection gates 16 in the mold cavity plate 28.

As shown in Figure 1, the nozzle 12 has one or more grooves 18 machined therein and extending along its longitudinal axis for housing a tubular heater 20 which keeps the plastic material within the melt channel 14 in a molten condition. A steel sleeve 22 is provided around a central portion of the nozzle 12 and serves to retain the heater 20 in the groove(s) 18. If desired, a heater 20' may also be housed in a groove in the tip end 40 of the nozzle 12. The heater 20' could be part of the heater 20 or alternatively may be a separate heater. The heater(s) 20, 20' may comprise any suitable heater known in the art.

An annular insulator 24 is preferably positioned between the head 26 of the nozzle 12 and the mold cavity plate 28 to reduce the amount of heat transferred from the nozzle 12 to the mold cavity plate 28. As can be seen from Figure 1, the insulator 24 surrounds a portion of the sleeve 22. It has a lower end 30 which rests on a surface 32 cut into the mold cavity plate 28 and an upper end 34 abutting a lower surface 36 of the nozzle head 26. The insulator 24 is held in place against the nozzle head by the sleeve 22. Preferably, the insulator is formed from steel, whose thin section 24 limits the flow of heat to the cavity plate.

Access openings 21 and 23 are provided in the nozzle 12 and/or the insulator 24 to permit wiring (not shown) to be connected to the heater(s) 20 and the thermocouple located at 100.

In accordance with the present invention, the nozzle assembly includes an annular seal ring 42 snugly fitted over the tip end 40 of the nozzle 12 and housed within a recess 46 defined by a lower portion of a bore 45 in the mold cavity plate 28. The seal ring, as shown in Figure 3, is formed by an annular body having a central bore 44 with a diameter D_1 which is substantially equal to the outer diameter of the tip end 40 of the nozzle 12. The seal ring also has an outer diameter D_2 which substantially corresponds to the diameter of the recess 46. When assembled, the seal ring 42 contacts the wall(s) of the bore defining the recess 46 about its entire periphery and extends about or surrounds the tip end 40 of the nozzle. Since contact between the seal ring and the recess wall(s) is not limited to a few locations, cocking is avoided and easy assembly/disassembly and proper alignment of the nozzle assembly is ensured.

As shown in the drawings, the seal ring 42 has a number of angled melt channels 56 machined therein. These angled melt channels mate with the angled melt channels 38 in the tip end 40 of the nozzle and form passageways which serve to transport molten plastic material from the melt channels 38 to the injection gates 16 in the mold cavity plate. Of course, the number and the location of the angled melt channels 56 in the seal ring corresponds to the number and the location of the angled melt channels 38 in the tip end of the nozzle. In addition to cooperating with a respective melt channel 38, each melt channel 56 is in communication with an orifice 54 drilled into the seal ring 42 which also forms part of the passageway for transporting plastic material. The number of orifices 54 drilled into the seal ring 42 and their locations correspond to the number and the locations of the gates 16 in the mold cavity plate 28. The orifices 54 permit molten plastic material within the channels 56 to flow into the gates 16. It should be recognized that one advantage of the design of the seal ring 42 is that many such orifices can be drilled into the ring about the ring periphery without causing any substantial weakening of the ring. Thus 8, 12 or even 16 small cavity gates can be accommodated from a single nozzle assembly fitted with the seal ring of the present invention.

Preferably, the seal ring 42 is made from a material having a thermal coefficient of expansion lower than the thermal coefficient of expansion of the material forming the nozzle 12. In this way, the nozzle 12 when heated will expand inside the seal ring 42. Since the outer periphery of the seal ring abuts the walls defining the recess 46, expansion of the nozzle will press the seal ring outwardly to seal against the wall(s) of the recess as well as cause a gripping effect on the seal ring 42. As a result, a good seal is formed between the seal ring and the mold cavity plate and between the melt channels 38 and 56 so that leakage of molten plastic material between the nozzle and the seal ring is avoided. In a preferred embodiment of the present invention, the seal ring is formed from titanium (a material having a thermal coefficient of expansion of 5.3×10^{-6} in/in/°F) or a titanium alloy, while the

nozzle is formed from steel (a material having a thermal coefficient of expansion of 6.8 x 10^{-6} in/in°F) or a copper alloy, such as BeCu25 or Ampco 945 having a thermal coefficient of expansion of 9.5 x 10^{-6} in/in/°F .

Two circumferential bubble grooves 48 and 50 and a circumferential film groove 52 are machined into the seal ring 42. The grooves 48, 50 and 52 extend about the entire periphery of the seal ring with the film groove 52 extending between the bubble grooves 48 and 50. In operation, at least some of the molten plastic material injected into the gates 16 via the angled melt channels 56 and the orifices 54 will initially fill the circumferential film and bubble grooves 48, 50 and 52 because the orifices 54 are in communication with the grooves. This plastic material acts as a thermal insulator. As a result, there is a minimization of the heat transferred via the seal ring 42 to the mold cavity plate 28.

It has been found that by using the seal ring of the present invention, there is no bleeding of the insulating plastic material into the main melt stream flowing through the orifices 54 and the gates 16. Thus, the sealed edge gate system of the present invention has particular utility in the processing of heat sensitive resins where degradation and contamination of the resin needs to be avoided. The sealed edge gate system of the present invention is also advantageous in that the improved thermal insulation properties obtained thereby mean that the nozzle heater 20 need not be operated unnecessarily high in order to overcome heat losses.

The design of the seal ring 42 is most advantageous in that when frequent color change or change of resin is required it maintains strength integrity and allows easy assembly/disassembly. Still further, the design provides an ability to offer more gates per nozzle which is an important benefit.

While the seal ring 42 has been illustrated as having an annular configuration, it should be recognized that the seal ring could have any desired configuration or shape.

Claims

1. A hot runner sealed edge gated injection molding system comprising:
   a nozzle (12) having a tip end (40) and at least one melt channel (14) for transporting molten plastic material, said at least one melt channel (14) extending into said tip end (40) of said nozzle (12); and
   an annular seal ring (42) snugly fitted over said tip end (40) of said nozzle (12), said seal ring (42) having at least one melt channel (56) for transporting said molten plastic material, said at least one melt channel (56) in said seal ring (42) mating with said at least one melt channel (14) in said nozzle (12).

2. The injection molding system of claim 1 further comprising:
   said at least one melt channel in said nozzle (12) comprising a central melt channel (14) and at least one angled melt channel (38) located within said tip end (40), said at least one angled channel (38) communicating with said central melt channel (14); and
   said seal ring (42) having at least one angled melt channel (56) mating with said angled melt channel (38) in said tip end (40).

3. The injection molding system of claim 1 or 2 further comprising:
   a mold cavity plate (28) having at least one injection gate (16); and
   said seal ring (42) having at least one orifice (54) communicating with said at least one injection gate (16) for enabling molten plastic material in said at least one melt channel (38) in said nozzle (12) to be transported to said at least one injection gate (16).

4. The injection molding system of claim 3 further comprising:
   said mold cavity plate (28) having a number of injection gates (16); and
   said seal ring (42) having a number of orifices (54) drilled therein about its periphery, said number of orifices (54) being equal to said number of injection gates (16) with each respective orifice (54) mating with one of said injection gates (16).

5. The injection molding system of at least one of claims 1 - 4 further comprising:
   a mold cavity plate (28);
   said seal ring (42) being in contact with said mold cavity plate (28) and having means for minimizing heat transferred from said seal ring (42) to said mold plate (28); and
   said heat minimizing means comprises two bubble grooves (48, 50) and a film groove (52) machined into said seal ring (42), said grooves (48, 50, 52) being filled by plastic material acting as a thermal insulator.

6. The injection molding system of claim 5 further comprising:
   said seal ring (42) being located within a recess (46) in said mold cavity plate (28) and being in contact with at least one wall defining said recess (46);
   said seal ring (42) being made of a material having a lower thermal coefficient expansion than the material forming said nozzle (12) so that

when said nozzle (12) is heated and expands within said seal ring (42) a gripping effect is created which ensures a good seal between said at least one melt channel (38) in said nozzle (12) and said at least one melt channel (56) in said seal ring (42);
said recess (46) having a diameter; and
said seal ring (42) having an outer diameter (D2) substantially equal to said diameter of said recess (46),
whereby expansion of said nozzle assembly (12) due to heating presses said seal ring (42) outwardly to seal against said at least one wall defining said recess (46).

7. The injection molding system of claim 6 further comprising:
at least one groove (18) extending along said nozzle (12);
at least one heater (20, 20') positioned within said at least one groove (18) to maintain said plastic material in said melt channels (14, 38) in a molten condition;
a sleeve (22) surrounding a portion of said nozzle (12) and serving to hold said at least one heater (20) in position;
an annular insulator (24) surrounding a portion of said sleeve (22);
said insulator (24) having a lower end (30) contacting said mold cavity plate (28) and an upper end (34) contacting said nozzle (12); and
said insulator (24) being held in place by said sleeve (22).

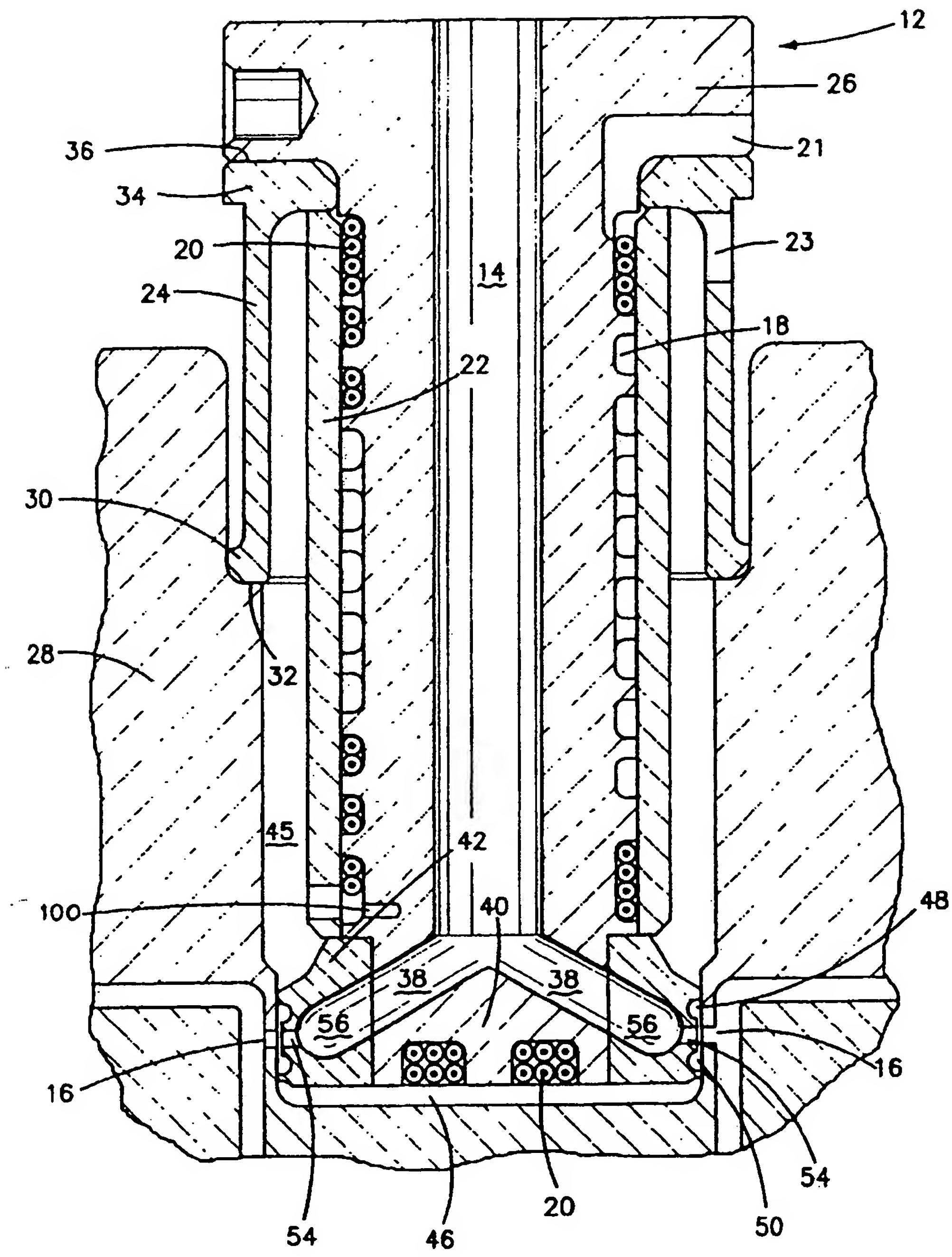
8. A sealed edge gate for use in an injection molding machine, said sealed edge gate comprising:
a mold cavity plate (28) having at least one injection gate (16);
a nozzle (12) having at least one melt channel (14, 38) for transporting molten plastic material; and
an annular seal ring (42) surrounding a portion of said nozzle (12), said seal ring (42) having at least one passageway (56) for transporting said molten plastic material from said at least one melt channel (38) to said at least one injection gate (16).

9. The sealed edge gate of claim 8 wherein said at least one passageway includes at least one melt channel (56) within said seal ring (42) and at least one orifice (54) in said seal ring (42) communicating with said at least one angled melt channel (56) within said seal ring (42).

10. The sealed edge gate of claim 9 wherein:
said seal ring (42) includes means for minimizing the transfer of heat between said seal ring (42) and said mold cavity plate (28);
said heat transfer minimizing means comprises two bubble grooves (48, 50) and a film groove (52) extending about the periphery of said seal ring (42), said bubble grooves (48, 50) and said film groove (52) being filled with plastic material acting as an insulator; and
said film groove (52) extends between said bubble grooves (48, 50)

11. A sealed edge gate for use in an injection molding system, said sealed edge gate comprising:
a mold cavity plate (28) having a plurality of injection gates (16);
a nozzle (12) having a central melt channel (14) for transporting molten plastic material, said melt channel (14) terminating in a plurality of angled melt channels (38);
a seal ring (42) extending about a tip end (40) of said nozzle (12), said seal ring (42) having a plurality of melt channels (56) mating with said angled melt channels (38) in said nozzle (12) and a plurality of orifices (54) about its periphery; and
each said orifice (54) being in communication with a respective one of said injection gates (16) and a respective one of said melt channels (56) in said seal ring (42) so as to enable molten plastic material in said nozzle (12) to be transported to said respective one injection gate (16).

12. The sealed edge gate system of claim 11 further comprising:
said nozzle (12) being formed from a thermally conductive material;
said seal ring (42) abutting against said mold cavity plate (28); and
said seal ring (42) being formed from a material having a lower thermal coefficient of expansion than the material forming said nozzle (12),
whereby said nozzle material expands at a greater rate than said seal ring material when said nozzle (12) is heated and thereby presses said seal ring (42) against said mold cavity plate (28) to create a sealing effect and creates a gripping effect on said seal ring (42) so as to substantially prevent leakage of plastic material between said nozzle (12) and said seal ring (42).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FIG–1

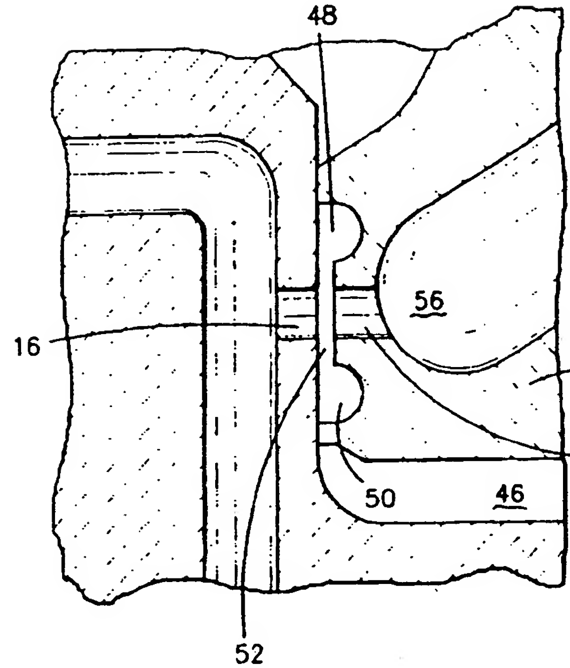

FIG-2

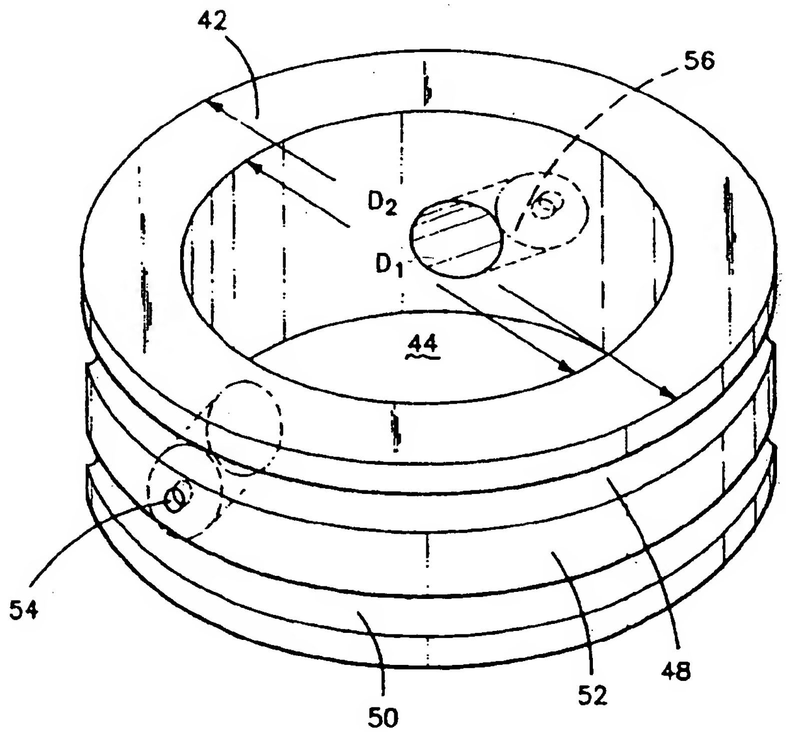

FIG-3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 93 11 5854

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
P,A	US-A-5 208 052 (SCHMIDT) * figure 3 *	1-5,8-11	B29C45/27
A	PLASTVERARBEITER vol. 37, no. 4 , April 1986 , SPEYER/RHEIN DE pages 124 - 127 LÖHL 'Stirnseitiger Mehrfachanschnitt als Problemlösung' * figure 2 *	1-4,8,9,11	
A	KUNSTSTOFFE vol. 72, no. 12 , December 1982 , MUNCHEN DE pages 749 - 755 LANGE 'Standard-Heisskanalsysteme' * figure 2D *	1,3,4,8,11	
D,A	EP-A-0 407 971 (MOLD-MASTERS) * the whole document *	1,3,5,8,10,11	TECHNICAL FIELDS SEARCHED (Int.Cl.5) B29C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 December 1993	Bollen, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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P : intermediate document

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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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